SEDAR 14

Stock Assessment Report 2

Caribbean Mutton Snapper

SECTION III. Assessment Workshop

SEDAR
4055 Faber Place #201
Charleston, SC 29405

SEDAR 14. Caribbean Mutton Snapper
Assessment Workshop Report

Table of Contents

1. Introduction

1.1. Workshop Time and Place

The SEDAR 14 Assessment Workshop was held June 4 - 8, 2007 in St. Thomas, USVI.

1.2. Terms of Reference

1. Review any changes in data following the data workshop and any analysis suggested by the data workshop. Summarize data as used in each assessment model. Provide justification for any deviations from Data Workshop recommendations.
2. Develop population assessment models that are compatible with available data and recommend which model and configuration is considered most reliable or useful for providing advice. Document all input data, assumptions, and equations.
3. Provide estimates of stock population parameters (fishing mortality, abundance, biomass, selectivity, stock-recruitment relationship, etc); include appropriate and representative measures of precision for parameter estimates.
4. Characterize uncertainty in the assessment and estimated values, considering components such as input data, modeling approach, and model configuration. Provide appropriate measures of model performance, reliability, and 'goodness of fit'.
5. Provide yield-per-recruit, spawner-per-recruit, and stock-recruitment evaluations, values, and figures.
6. Provide estimates for SFA criteria. This may include evaluating existing SFA benchmarks or estimating alternative SFA benchmarks (SFA benchmarks include MSY, Fmsy, Bmsy, MSST, and MFMT); recommend proxy values where necessary.
7. Provide declarations of stock status relative to SFA benchmarks.
8. Estimate an Allowable Biological Catch (ABC) range.
9. Project future stock conditions (biomass, abundance, and exploitation) and develop rebuilding schedules if warranted; include estimated generation time. Stock projections shall be developed in accordance with the following guidelines.
   A) If stock is overfished:
      F=0, F=current, F=Fmsy, Ftarget (OY),
      F=Frebuild (max that rebuild in allowed time)
   B) If stock is overfishing:
      F=Fcurrent, F=Fmsy, F= Ftarget (OY)
   C) If stock is neither overfished nor overfishing:
      F=Fcurrent, F=Fmsy, F=Ftarget (OY)
10. Evaluate the results of past management actions and, if appropriate, probable impacts of current management actions with emphasis on determining progress toward stated management goals.

11. Provide recommendations for future research and data collection (field and assessment); be as specific as practicable in describing sampling design and sampling intensity.
12. Complete the Assessment Workshop Report (Section III of the SEDAR Stock Assessment Report) and prepare a first draft of the Assessment Advisory Report.

1.3. Workshop Participants

NAME **Affiliation**

Workshop Panel

Richard Appeldoorn.....CFMC SSC/UPRM
Daniel Matos-Cayaballo .....PR DNER
Nancie Cummings.....NMFS SEFSC
Guillermo Diaz.....NMFS SEFSC
Ron Hill.....NMFS SEFSC
Joe Kimmel ..... NMFS SERO
Andy Maldonado ..... CFMC AP
Kevin J. McCarthy.....NMFS SEFSC

Council Representative

David Olsen ..... CFMC/VI DWF

Staff

John Carmichael..... SEDAR
Graciela Garcia-Moliner ..... CFMC
Patrick Gilles.....NMFS SEFSC
Rachael Lindsay..... SEDAR

1.4. Workshop Documents

Working Papers

SEDAR14-AW1	An Examination of the Mutton snapper, Lutjanus analis, Commercial Catch per Unit of Effort Data in Puerto Rico from 1983-2005 Available for Use in Developing Estimates of Abundance	Cummings, N
SEDAR14-AW2	Habitat based analysis Mutton	Jeffries, C.
SEDAR14-AW3	Habitat based analysis conch	Jeffries, C.
SEDAR14-AW4	On diver catch-per-unit-effort series as measures of relative abundance of queen conch and their use in stock assessments for the islands of Puerto Rico and Saint Croix	Diaz, G.
SEDAR14-AW5	Estimation of mutton snapper total mortality rate from length observations.	Gedamke
SEDAR14-AW6	Revised queen conch (Strombus gigas) standardized catch rates for Puerto Rico and U.S. Virgin Islands commercial fisheries	McCarthy, K. J.
SEDAR14-AW7	Comments on Puerto Rico landings and biostatistical sampling	Matos, D.

Reference Documents

SEDAR14 RD09 NMFS-SEFSC-304 1992	Shallow water reef fish stock assessment for the U.S. Caribbean.	Appeldoorn, R. et al.
SEDAR14-RD10	Coral reef fisheries uses in Puerto Rico and USVI.	anon.
SEDAR14-RD11 SFD-02/03-184 2002	Standardized catch rates and preliminary assessment scenarios for queen conch (Strombus gigas) in the U.S. Caribbean	Valle-Esquivel, M.
SEDAR14-RD12 SFD-01/02-169 2002	U.S. Caribbean queen conch (Strombus gigas) data update with emphasis on the commercial landings statistics.	Valle-Esquivel, M.
SEDAR14-RD13 NMFS-Pro. Paper 5	Detecting fish aggregations from reef habitats mapped with high resolution side scan sonar imagery.	Rivera, J. A. et al.
SEDAR14-RD14 Bull Mar Sci 62(2) 1998	VARIATION IN NATURAL MORTALITY. IMPLICATIONS FOR QUEEN CONCH STOCK ENHANCEMENT	Stoner, A. & R. A. Glazer
SEDAR14-RD15 Fish Bull 96:885-899 1998	Settlement and recruitment of queen conch, *Strombus gigas*, in seagrass meadows: associations with habitat and micropredators	Stoner, A. W., M. Ray-Culp, S. M. O'Connell
SEDAR14-RD16 Mar Ecol Prog Ser 202:297-302 2000	Evidence for Allee effects in an over-harvested marine gastropod: density-dependent mating and egg production	Stoner, A. W. and M. Ray-Culp
SEDAR14-RD17 ICES Mar. Sci Symp 199:247-258 1995	Stock assessment of a large marine gastropod (*Strombus gigas)* using randomized and stratified towed diver censusing.	Berg, C. J. Jr., and R. A. Glazer
SEDAR14-RD18 Sociedad de Cinecias Naturales La Salle. Tomo XLVIII. Supl No. 3 1988	COMMERCIAL CATCH LENGTH-FREQUENCY DATA AS A TOOL FOR FISHERIES MANAGEMENT WITH AN APPLICATION TO THE PUERTO RICO TRAP FISHERY	Dennis, G.
SEDAR14-RD19 Mar Ecol Prog Ser 257:275-289 2003	What constitutes essential nursery habitat for a marine species? A case study of habitat form and function for queen conch	Stoner, A. W.
SEDAR14-RD20 Jou. Shellfish Res 15(2) 407-420 1996	LARVAL SUPPLY TO QUEEN CONCH NURSERIES: RELATIONSHIPS WITH RECRUITMENT PROCESS AND POPULATION SIZE IN FLORIDA AND THE BAHAMAS	Stoner, A. W., R. A. Glazer, P. J. Barile
SEDAR14-RD21 Mar Ecol Prog Ser 106:73-84 1994	High-density aggregation in queen conch *Strombus gigas:* formation, patterns, and ecological significance	Stoner, A. W. and J. Lally
SEDAR14-RD22 J. Shellfish Res. 17(4) 955-969 1998	MESOSCALE DISTRIBUTION PATTERNS OF QUEEN CONCH *(STROMBUS* GZGAS LINNE) IN EXUMA SOUND, BAHAMAS: LINKS IN RECRUITMENT FROM LARVAE TO FISHERY YIELDS	Stoner, A. W., N. Mehta, and M. Ray-Culp.

SEDAR14-RD23 Mar Bio 116:571-582 1993	Aggregation dynamics in juvenile queen conch *(Strombus gigas)* : population structure, mortality, growth, and migration	Stoner, A. W., R. Ray
SEDAR14-RD24 Fish Bull 94:551-565 1996	Queen conch, *Strombus gigas*, in fished and unfished locations of the Bahamas: effects of a marine fishery reserve on adults, juveniles, and larval production	Stoner, A. W.
SEDAR14-RD25 Fish Bull 92:171-179 1994	Queen conch, *Strombus gigas*, reproductive stocks in the central Bahamas: distribution and probable sources	Stoner, A. W., K. C. Schwarte
SEDAR14-RD26 Mar. Fish. Rev. 59(3) 1997	The status of queen conch research in the Caribbean	Stoner, A. W.
SEDAR14-RD27 TAFS 135:476-487 2006	Estimating Mortality from Mean Length Data in Nonequilibrium Situations, with Application to the Assessment of Goosefish	Gedamke, T., Hoenig, J. M.
SEDAR14-RD28 Fed-State Proj. No. NA77F0087 2000	Puerto Rico/NMFS Cooperative Fisheries Statistics Program 1997-2000	Matos, D.
SEDAR14-RD29 PR DNER 2004	Comprehensive Census of the Marine Fishery of Puerto Rico, 2002	Matos, D.
SEDAR14-RD30 CMFC Report 1984	Report on the reef fish size frequency survey July - September 1983	Morales-Santana, I.
SEDAR14-RD31 CFMC 1997	International queen conch conference proceedings, San Juan, PR, July 1996	Posada, J. M. and G. Garcia, eds.
SEDAR14-RD32 NOAA/NOS undated NA03NOS426024	Marine resource conditions for reef fishes and seagrass around St. John, USVI: Historical to present	Beets, J. and L. Muehlstein.
SEDAR14-RD33 SEFSC undated manu.	Queen conch CPUE assessment in PR & USVI's : Preliminary report.	Rivera, J. A.
SEDAR14-RD34 UPR/SEAMAP-C 2005	St. Croix and St. Thomas/St. John fisheries independent trap and line survey, 1992-2002.	Whiteman, E. A.
SEDAR14-RD35 PR Dept. of Agr., Agr. and Fish. Contr. IV(4) 1972	A report on fisheries statistics program in Puerto Rico from 1967 to 1972	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD36 PR Dept. of Agr., Agr. and Fish. Contr. III(1) 1975	La Pesca en Puerto Rico, 1970	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD37 Comm Fish. Rev. USFWS Reprint 866 1970	Puerto Rico's commercial fisheries. A statistical review.	Suarez-Caabro, J. A.
SEDAR14-RD38 PR Dept. of Agr., Agr. and Fish. Contr. II(1) 1975	Puerto Rico commercial fisheries, 1968-1969	Suarez-Caabro, J. A.

SEDAR14-RD39 PR Dept. of Agr., Agr. and Fish. Contr. IV(1) 1972	Status of fisheries in Puerto Rico, 1971.	Juhl, R. & J. A. Suarez Caabro
SEDAR14-RD40 PR Dept. of Agr., Agr. and Fish. Contr. V(3) 1973	Status of fisheries in Puerto Rico, 1972.	Suarez-Caabro, J. A.
SEDAR14-RD41 PR Dept. Nat. Res; Fish. Res. Lab. Tech. Rpt. 1(1) 1986.	Overview of Puerto Rico's small scale fisheries statistics, 1972 - 1978	Weller, D. & J. A Suarez-Caabro.
SEDAR14-RD42 PR Dept. of Agr., Agr. and Fish. Contr. VII(1) 1975	Status of fisheries in Puerto Rico, 1974.	Rolon, M.
SEDAR14-RD43 PR Dept. of Agr., Agr. and Fish. Contr. VIII(4) 1976	Status of fisheries in Puerto Rico, 1975.	Suarez-Caabro, J. A. & M.A. Abreu Volmar
SEDAR14-RD44 PR Dept. of Agr., Agr. and Fish. Contr. IX(1) 1978	Status of fisheries in Puerto Rico, 1976.	Abreu Volmar, M. A.
SEDAR14-RD45 CODREMAR, Fish. Res. Lab. Tech. Rpt. 1(2) 1987-1988	Status of fisheries in Puerto Rico, 1979-1982	Collazo, J. & J. A. Calderon
SEDAR14-RD46 NMFS/SERO State-Fed Proj. SF23 1986	CODREMAR/NMFS Cooperative statistics program. Completion report.	Garcia-Moliner, G. & J. Kimmel
SEDAR14-RD47 Comm. Fish. Res. and Dev. Act Pgm. 2-395-R 1986	Puerto Rico commercial fisheries statistics for 1983 - 1986.	Garcia-Moliner, G. & J. Kimmel
SEDAR14-RD48 PR Dept. Nat. Res; Fish. Res. Lab. Tech. Rpt. 1(1) 1994	Overview of Puerto Rico's small scale fisheries statistics, 1983 - 1987	Matos, D. and C. R. Alvarez

2. Panel Recommendations and Comment

2.1. Discussion and Recommendations Regarding Data Modifications

The Puerto Rico commercial landings data for mutton snapper were examined at the DW. The data indicated that the majority of the landings are from the trap and/or pots and hook and line fishery (SEDAR14 AW-01, Table 1). Historically throughout the 23 year time series, 1983-2005, removals from hook and line gear have accounted for some 46% of the removals across all years while pots or traps have accounted for about 28.5% (SEDAR14 AW-01, Table 2). Although landings were reported form the diving and net fisheries, there were insufficient data to carry out CPUE standardization analysis. The numbers of observations of CPUE were insufficient temporarily and spatially for these minor gears to develop a time series of standardized CPUE ((SEDAR14 AW-01, Table 1). SEDAR14 DW7 provided information on the nominal CPUE trends for both the minor and major gears (Table 2) There were no separate mutton snapper landings reported for the USVI. The very limited information available for mutton snapper from the USVI is specifically from the spawning aggregation. Species composition samples were insufficient to partition the aggregate samples. The SEDAR14 DW catch report provides information on the available samples from the USVI reef fish fisheries. Therefore, no CPUE models were attempted for the US Virgin Islands mutton snapper population due to the lack of species specific landings information.

At the SEDAR14 Data Workshop the Panel reviewed preliminary information on mutton snapper nominal catch per unit of effort (CPUE) in Puerto Rico. SEDAR14 DW-07 was provided as a background document describing data available for characterizing CPUE. Previous CPUE analyses from SEDAR8 for yellowtail snapper evaluated the Puerto Rico landings records for yellowtail snapper (SEDAR8) including only included successful catches in the analyses and included all landings areas into the analyses. The SEDAR14 DW Panel recommended that the SEDAR14 mutton snapper CPUE analysis include trips that also could possibly have landed mutton snapper but did not, in addition to successful or positive trips. The Panel recommended that the Stevens-MacCall (2004) approach be evaluated to select 0 trips. SEDAR14 AW1 document provided the background and Stephens McCall results indicated that of over 200 unique species indicated as being landed in Puerto Rico's reef fish fishery, 69 species were landed in 75% of all trips, and of these 32 were found to be significant with the mutton snapper.

The group also identified the principal landings areas for mutton snapper to determine the potential trips for harvesting mutton snapper. In addition to selection of zero trips for inclusion into the CPUE dataset, the Panel discussed the quality of the early years of the landings data. A recommendation was made to only consider the landings data from 1988 on for CPUE analysis. The data from the years 1983 to 1988 were not used because these were the years of the implementation of the sampling protocol and thus not considered reliable.

2.2. Discussion and Critique of Each Model Considered

2.2.1. *CPUE Models*

SEDAR14 AW01 describes the CPUE standardization analysis for the Puerto Rico mutton snapper landings and summarized data availability (Table 2). General linear models were applied to each separate set of CPUE observations for the hook and line and the trap fishery. The measure of CPUE was the landed weight (round pounds) for each unique trip. SEDAR14 DW07 described the procedure used to identify unique fishing trips. The approach used to derive the standardized

index utilized the Lo et al. (1992) delta-lognormal model which fits a log-normal model to the positive CPUE data and a binomial model to the proportion of positive data with the resulting index being a combination of the two. A normal error distribution was assumed for the positive log(CPUE) data and a binomial distribution was assumed for the proportion of errors. The estimated probability of the proportion of positives was a linear function of the fixed main effects (e.g., year, area, and month). Municipality identification code was a proxy of area in the mutton CPUE analyses. The model evaluations were made using the generalized linear modeling Glimmix and the Mixed procedure (Version 8.02 of the SAS System for Windows © 2000, SAS Institute Inc., Cary, NC, USA).

SEDAR14 AW-01 described the steps for the mutton snapper CPUE model fitting. Several CPUE models were attempted for each gear based fishery. These models explored the effect of several independent variables to explain CPUE. The independent variables available for these data were very few including year, area and month. The analyses were carried out separately for each of the major gear based fisheries (i.e., traps and hook and line) because of the operational differences in the two fisheries. The procedures and methods used to select the final model were included in the SEDAR14 AW01 document. The model selected as best characterizing the mutton snapper CPUE was based on the analysis of the deviance and diagnostic results from each fit after evaluating the input of each main effect (e.g., year, area, month) and in some cases one or more interaction terms (e.g., Year*Area, Year*Month, Area*Month). The diagnostic results included evaluation of the residual distributions of the fits, the AICC statistic, and the overdispersion statistic.

2.2.2. *Length Based Mortality Estimator*

Document SEDAR14-AW-05 presented the results of a length based total mortality (Z) estimator. Due to data insufficiencies, the method could only be applied to the mutton snapper trap fishery in Puerto Rico (Table 3). Although it was felt that there were adequate sample sizes to consider application of the length model to the Puerto Rican samples it was noted that the sampling intensity was very variable in Puerto Rico. Mutton snapper sampling intensity ranged from 0 % to 3.6 % for both the hook and line and trap fishery between 1983 and 2005, averaging 0.97% and 0.60% respectively. It was also noted that in some years, mutton snapper sampling intensity was disproportionate to the level of landings for some gears. There were insufficient samples collected for St. Thomas and/or St, Croix fisheries to consider application of this model (Tables 5 and 6). The length based mortality method applied here is based on the Beverton and Holt length-based mortality estimator (Beverton and Holt, 1956, 1957) which was modified by Gedamke and Hoenig (2006) to accommodate non-equilibrium situations.

2.2.3. *Production Models*

The panel also discussed the possibility of using a surplus production model (ASPIC) to assess the status of mutton snapper in Puerto Rico. A production model requires a series of total landings and an index of abundance or total effort as inputs. Commercial landings removals exist back to 1983 however recreational landings are unknown for the island of Puerto Rico before 2000. The panel discussed the possibility of using either total human population or number of registered recreational boats as a proxy for fishing effort to estimate recreational landings back in time using MRFSS estimated landings for 2000-2005. MRFFS landings are estimated as number of fish. In addition, the estimates of recreational catches of mutton snapper were characterized by high CV's. Because a production model requires landings in biomass, any estimated landings using MRFSS estimates required a conversion from numbers to biomass. Size samples from MRFSS 2000-2005 ranged only from 8 to 34 per year (SEDAR-DW-03). Given the small number of fish sampled by MRFSS and the change of mutton snapper mean length through time as a result of fishing pressure (SEDAR-AW-05), it was agreed by the panel not to estimate recreational landings for the years prior to 2000 because of the large number of uncertainties (i.e., lack of recreational catch, inadequate samples of size to convert numbers to biomass, large CV's in estimates); therefore,

precluding the use of a surplus production model (ASPIC) to assess the mutton snapper fishery in Puerto Rico.

2.2.4. Habitat Based Model

SEDAR14 AW02 provided estimates of mutton snapper abundance based on visual census surveys conducted in the nearshore mapped hard and soft bottom habitats off the southwest coast of Puerto Rico (La Parguera) and off the northeast coast of St. Croix (Buck Island) and St. John between 2001 and 2006. Observed frequencies of mutton snapper were expanded to totals based on benthic map spatial extent. The group noted felt that the unexpanded estimates provided information on relative levels over the combined six year period, 2001-2006 from the areas surveyed.

2.3. Preferred Model, Configuration, and Summary of Model Issues Discussed

2.3.1. *CPUE Models-*

Hook and Line Fishery CPUE

The annual standardized mutton snapper CPUE indices for Puerto Rico hook and line fishery are provided in Table 7 and Figure 1. Models were calculated for the hook and line fishery CPUE data from 1989 through 2005. The final model structure fitted to the positives log(CPUE) observations from the hook and line fishery was:

log(CPUE)=Year + Municipality + Month + Year * Municipality

The final model structure fitted to the proportion of positives observations from the hook and line fishery was:

Proportion Positives = Year + Municipality + Month + Year*Municipality.

Trap Fishery CPUE

The annual standardized mutton snapper CPUE indices for Puerto Rico trap are provided in Table 8 and Figure 2. Models were calculated for the pot fishery CPUE data from 1990 through 2005. When data from 1989 was incorporated into the model the models did not achieve convergence. The final model structure fitted to the positive log(CPUE) observations from the trap fishery was:

log(CPUE) = Year + Municipality + Month + Municipality*Month.

The final model structure fitted to the proportion of positives observations from the trap fishery was:

Proportion Positives = Year + Municipality + Year*Municipality

Discussion of the model fitting characteristics occurred. The mutton snapper Puerto Rico CPUE standardization models did not include many variables. This is an artifact of the way in which the landings data were recorded as few attributes are requested on the landings sales record form. In addition, the amount of the total variance explained by the models was low suggesting the models were uninformative. This result could be due to the lack of information available regarding the CPUE data to characterize the model. The diagnostic results for the lognormal fits to the positive log CPUE observations for both the trap and the hook and line fishery did not suggest any major violation of assuming the lognormal model for the mutton CPUE data (Figures 3 and 4). Also, the distribution of the residuals did not suggest strong tendencies in the patterns. It was noted that the number of successful trips landing mutton snapper over the period of the analysis time series was

very low for both the hook and line and the trap fishery (Figures 5 and 6). The proportion of positives for the hook and line fishery ranged from about 6.2% to 14.2% averaging 10% across all years but was very low particularly between 1993 and 1997.

The proportion of positive for the trap fishery ranged from about 3.8 % to 21.2 % averaging 10.3% (Figures 7 and 8). The diagnostic results from the fits of the individual CPUE models suggested that overdispersion was present in the proportion of positives observations in both the hook and line and the pot fishery data. This could suggest the binomial model did not adequately fit the proportion of positives data or also that the model structure (i.e., information contained in the model description) was not adequate for explaining the variability in the proportion of positives. Figures 9 and 10 illustrate the residual distribution for the proportion positives fitted from the final delta lognormal model by year, for mutton snapper from the Puerto Rico line fishery, 1989-2005. The lognormal model fit to the positive log CPUE data did not suggest overdispersion in the data for either the hook and line or the trap fishery.

The SEDAR14 AW group reviewed the mutton snapper final standardized CPUE trends presented in SEDAR14 AW-01 and also results from the hook and line fishery sensitivity run. It was noted that for the hook and line fishery that the pattern of standardized CPUE suggested little trend in CPUE over the period, 1989-2003. Only the last two years of the series indicated a slight increase. The mutton snapper pot fishery standardized CPUE indicated an increase in CPUE occurring between 1990 and 1998 and again from 2000-2002. The group discussed if the Puerto Rico CPUE indices can be considered reflective of stock abundance. The group noted that no information had been presented to indicate that the indices were not reflective of abundance.

During the AW the Panel recommended to explore a sensitivity model for the hook and line fishery that excluded the observations for the spawning closure months of April and May for 2004 and 2005. The model structure was the model that resulted from the best fit hook and line CPUE model from the above description. The resulting trends in estimated standardized CPUE from this sensitivity trial were unchanged (Figure 11) thus the selection of the final standardized indices were unchanged changed from the base case scenario (Tables 7 and 8).

The group also recommended updating the mutton snapper CPUE indices to include new data from 2006 as that was made available during the AW. This task will be evaluated after the AW and any updated or new indices made available for the SEDAR RW workshop.

2.3.2. *Length Based Mortality Estimator*

Length of full vulnerability, L_c, was estimated to be 300 mm FL. Three different cases or scenarios were developed by creating separate time series for: 1) mean lengths calculated for each separate or unique interview day, 2) mean lengths calculated by month strata and 3) mean length calculated by year strata.

The chosen base case was the times series estimated using average length by interview day and runs were performed with and without weighting the data by the sample size of each estimated mean length. The aggregation of data over the larger time scales had little effect on the weighted functions (Table 9) which appeared to be driven by a few samples with unusually high sample number and large fish (see years 2001 and 2002).

During the SEDAR14 AW, it was discussed with the Puerto Rico DNER Port Agent supervisor (D. Matos-Caraballo, SEDAR14 AW07) the validity of those samples containing high numbers of observed large fish. It was agreed that it was unlikely to have caught that many large mutton snappers in a single trap trip. The port agents believed that those records were miscoded and they most probably correspond to catches made by hook-and-line gear fishing on the spawning aggregations. It was therefore agreed to exclude those observations and rerun the length based model.

2.3.3. *Production Model*

Production models were not explored for mutton snapper at the SEDAR 14 due to the large uncertainty regarding total removals. Data exists since 1983 to describe commercial removals however, the level of uncertainty around estimating the recreational component from lack of catch information, short time series, and inadequate samples to convert estimates of catch in numbers to biomass would substantial uncertainty to the analysis.

2.3.4. *Habitat based Model*

Estimates of total abundance of mutton snapper from 2001-2006 from the habitat based estimator are given in Table 10. The areas surveyed are shown in Figure 12. In Puerto Rico, the estimate ranged from 4,979 to 32,750 individuals with a mean of 18,865 sexually immature fish and zero adult fish. It is important to note that the estimate in Puerto Rico is based only on the occurrence of three juvenile fish. In St. Croix, total mutton snapper abundance ranged from 41,487 to 136,943 individuals with a mean of 106,678 individuals. In St. John, total mutton snapper abundance ranged from 3,698 to 28,986 individuals with a mean of 16,342 fish. The large range in these estimates result from the high variability in occurrence of mutton snapper among different habitats as noted by SEDAR14 AW02. Juvenile and adult mutton snapper varied somewhat in their distribution among habitats, with juveniles being more common in mud, sand and seagrass habitats and adults being more frequently observed in hard bottom habitats (SEDAR14 AW02-Figure 2).

The panel noted that the expansions were based on the benthic map spatial extent and thus the resolution of the estimates was dependent on the accuracy and resolution of the habitat maps. The group felt that the frequency of occurrence information could be considered as relative information for the period of study, 2001-2006. It was recommended that the estimates be validated through estimates from other habitat studies if available. The group noted that the surveys were from localized areas off Puerto Rico, St. Thomas and St. Croix and whether the estimates reflected total island population sizes could not be determined.

2.4. Recommended Parameter Estimates

A full stock evaluation could not be performed for the US Caribbean mutton snapper stock due to inadequate data therefore recommendation for stock status parameters (stock biomass, fishing mortality, selectivity) were not determined. Some information was derived on relative abundance levels from CPUE observations.

2.5. Evaluation of uncertainty and model precision

2.5.1. *CPUE Indices*

The group discussed the results of the mutton CPUE analyses and noted that for the hook and line fishery there was little trend in CPUE, if any only a slight increase in CPUE, until the rather sharp increase predicted for the last two years around 2003 (Table 7, Figure 1). In the trap fishery, the trend of CPUE showed a relatively flat CPUE through 1998, then a sharp increase in 1999 followed by another increase in 2003 (Table 8, Figure 2). It was noted that the increase in CPUE predicted in 2003 coincided with changes in regulations of a seasonal closure during April and May. There was some discussion by the Panel as to effects of climate changes in the 1990's, in

particular drought conditions that may have impacted mutton snapper population sizes. Evaluating this environmental impact on CPUE was not possible with the current data set as information on species landings is not available before 1989.

Estimated CV's around the standardized CPUE indices were reasonably low. CV's for the hook and line fishery ranged from 14-22% while the pot fishery CPUE's were somewhat more variable with CV's ranging from 18-32% (Tables 7 and 8). The panel discussed whether the standardized CPUE mutton indices were reflective of stock abundance. It was agreed that there was no reason identified to either doubt or discard the indices.

2.5.2. *Length Based Mortality Estimator*

The panel noted that the Puerto Rico trap length data showed evidence of clear length truncation (Figure 13). In addition sample sizes ranged from very low to some very high (Table 3). In a few cases with large numbers of observations, there were clear outliers of larger mean length. There was additional discussion on the use of the procedure to derive estimates of population parameters (e.g. mortality). It was noted that this gear does not usually target mutton snapper, but apparently that mutton may have an affinity for this gear. It was also noted that traps caught a wide range of available sizes. It was also noted that fishers can keep what they catch, so landings length composition is probably reflective of catch length composition and also length samples are taken randomly by the Puerto Rican port agents. One concern noted was that the very largest mutton may not be able to get in the trap. This may or may not be a major bias. The group felt therefore that the trap length composition may be reasonable reflection of the population length composition. It was emphasized however that the key output from the length data should be considered in terms of trends in mortality over time, not so much as an absolute estimate.

This type of analysis shows promise for this type of data limited situation. Unfortunately, data were even too limited in regionally specific fisheries to apply the model (e.g., St. Thomas, St. Croix). In the one case (Puerto Rico trap fishery) where sufficient samples were taken, the high variability of the data leads to significant uncertainty surrounding the absolute values presented in this analysis. It is also important to note that there is an apparent discrepancy between the conclusions of the length-based analysis (i.e., indicating increased mortality around 1990) and the trend in the indices (i.e., indicating increasing abundances by the late 1990's). There are two aspects of the length-based analysis to consider. First, given the high variability in the length data that were analyzed, any reduction in fishing mortality that may have occurred after the estimated increase in 1990 would be difficult to detect. Secondly, the model assumes constant recruitment and a violation of this assumption, in the form of an increase in recruitment, would make the mean length smaller (i.e. overestimate mortality) while at the same time explain the increase in catch rates. Generally, the assumption of constant recruitment is not unreasonable for most teleost fish over relatively small changes in stock sizes, but results should be used with caution until information on recruitment is available. Simulations of the length based analysis to the constant recruitment assumption violation demonstrate that the magnitude of trend in recruitment will reflect the magnitude of bias in the total mortality estimate (i.e. a 10% trend of increase in recruitment will result in a 10% overestimation of total mortality).

The panel requested further evaluation of the length model to include the CPUE indices possibly as weighting factors for consideration by the review Panel. The evaluation would apply to the Puerto Rico samples only as sufficient length statistics were not available for the USVI fisheries.

2.5.3. *Habitat Model*

Relative abundance information was provided through expansions of frequency of occurrence information from visual census information (SEDAR14-AW02). SEDAR14 AW02 noted that that large variability in frequency of occurrence existed among the different habitats, resulting in a large range of estimated population levels.

2.6. Discussion of YPR, SPR, Stock-Recruitment

The Panel discussed whether a yield per recruit analysis (YPR) was appropriate for the mutton snapper population. It was noted that such analysis would require input of necessary life history growth parameters from outside the study area. It was noted that although such assumptions could be made that in addition these parameters would be based on observations from commercial fisheries. In addition information on recreational selectivity was not available from any source for mutton snapper in the US Caribbean. Additional uncertainty concerned lack of information on current fishing mortality to evaluate what current YPR was.

2.7. Recommended SFA parameters and Management Criteria

The US Caribbean mutton snapper population is currently managed under criteria adopted for Management Unit 3. Table 11 provides the current SFA parameters and criteria.

2.8. Status of Stock Declarations

A full evaluation of stock status was not possible for the mutton snapper stocks in the US Caribbean due to the insufficiency of information regarding population levels. Some information was derived yielding information on trends in CPUE since 1983 for the two dominant fisheries exploiting the mutton snapper in Puerto Rico. CPUE information was not available for the remaining islands (St. Thomas/ST. John or St. Croix). In addition application of a length based model provided information on general trends in total mortality since 1983.

2.9. Recommended ABC

Calculations of ABC were not possible for mutton snapper because status of stock could not be determined.

2.10. Discussion of Stock Projection

Population projections were not possible for the US Caribbean mutton snapper stocks.

2.11. Management Evaluation

2.11.1. Effectiveness/impacts of past management actions

Mutton snapper populations in the US Caribbean have been subject to a seasonal area closure in St. Croix since 1993 (in the EEZ) and 1994 in the state waters of St. Croix (Figure 14). The SFA Amendment to the FMPs (2005) established a seasonal closure for mutton snapper for all of the EEZ during the months of April through June. The US VI established a seasonal closure in 2006 during the same months, April through June. Puerto Rico established a seasonal closure in 2004 for the month of April, in 2007 amended the closure to cover April and Month.

- Have size, bag, harvest limits etc. affected the stock? achieved objectives?
- evaluation of rebuilding strategy (if implemented)

Effects of management strategies such as recreational bag limit and/or commercial harvests guidelines for mutton snapper cannot be evaluated as there is no history of these actions on the resource. The fishery is not under quota management. The current status of the mutton snapper populations in the US Caribbean is not known thus overfishing status has not been determined and therefore no rebuilding strategy is in effect. Impacts from federal and/or state seasonal closures have not yet been evaluated.

2.12. Research Recommendation Research Recommendations

Table 12 provides a comprehensive overview of the availability of information for U.S. Caribbean mutton snapper populations, This table in addition to the following discussion provides a synthesis of the groups thoughts regarding sufficiency and quality of the data available for use in evaluating the stock status of the mutton snapper population in this region. Due to the current categorization of mutton snapper as undergoing overfishing, this species should be prioritized in all data collection efforts in the US Caribbean both in dependent and fishery independent programs. Obtaining information required to assess the impact of regulations on management measures is needed. Targeted research efforts are needed to determine relative abundance, CPUE, length and age structure of catch for all commercial and recreational gears used to harvest mutton snapper. The group noted the need to monitor population densities at seasonal closed areas to open areas to determine effects of management and to monitor compliance. The only area closure for mutton snapper is off St. Croix and the closure has been in place since 1993. There has been no monitoring in this area since the closure took effect. In addition there is no current mechanism of enforcing the spawning seasonal closure.

2.12.1. Dependent Data Collections

At the SEDAR14 AW the group discussed the importance of accurate and reliable information regarding the catch. Fishery dependent data collection (i.e., commercial fishery) should be continued and improved with emphasis on priority species (in this case mutton snapper). The group noted that a review of the field methods and protocols of the fishery data collection systems in the U.S. Caribbean needs to be conducted to evaluate what relevant attributes need to be collected to characterized trip specific catch. Such a review should be conducted in collaboration with all the primary agencies responsible for management of these species to assess appropriate sampling levels and priority species (or groups of species) and prioritize fisheries. Species landings information should be collected at a resolution so CPUE can be determined for each gear used to harvest this species. Accurate information must be recorded to identify each individual fisher, location and date of catch and where possible depth of catch. For all primary harvest gears, optimum CPUE should be in terms of number of individuals, biomass, and the amount of effort in hook-hours (i.e., time hooks are in the water) or trap soak-time in hours. The group also emphasized the need to review the catch sampling intensity protocols prescribed by the NMFS, SEFSC, Trip Interview Program for sampling catches as a guideline for setting catch length frequency sampling needs. As a starting point the current TIP target of taking 25-30 individual lengths and weights per trip should be considered as a guideline for sampling of individual catches. When sub-sampling occurs the sampling fraction must be recorded. In addition, information should be collected to determine whether fish were captured in a spawning aggregation or otherwise. Where appropriate, information on directed fishery discards should be collected and, the fate (i.e., dead, alive) and size of individuals of the discards characterized. The group also noted the importance of monitoring the fishery accurately as relates to the intra-day variability. The group emphasized that the MRFSS sampling program should add additional

survey attributes to draw out information on mutton snapper throughout the U.S. Caribbean. The group emphasized the need to continuous recreational fishery data collection in the US. VI. In addition, the sampling effort of the MRFSS intercepts should be increased to a level that would result in adequate sample sizes for biological characterization. The use of research initiatives such as CRP, MARFIN and Sea Grant were encouraged as funding mechanisms for the collection of such critically needed data.

2.12.2. Fishery Independent

The group emphasized the need to continue and enhance the current fishery independent program(s) to better evaluate abundance indices for mutton snapper populations cross insular platforms in habitats where these fish are known to occur as well as for known spawning aggregations. During such monitoring length of individuals, location, depth, time of day of sample collection, and habitat should be noted. Visual counts or directed gear sampling (i.e., hook-and-line, traps, spear fishing, nets, etc.) are possible monitoring gear as well as possible camera devices. Life history information to determine age, size, growth, reproduction (size of maturity, fecundity, spawning behavior, stock identification) is needed. The group encouraged the use of already existing research funding opportunities including CRP, MARFIN, and Dingell Johnson (Johnson) programs for the collection of such critically needed data. The group emphasized the need to coordinate life history studies between key agencies to collect and assemble time series of information on life history attributes including age, growth, and maturation. In addition, individuals conducting basic life history studies are encouraged to collaborate with other external groups including NMFS, SEFSC Panama City and Beaufort Laboratories, with existing protocols and methods for similar species.

The group encouraged reference to supporting efforts by SEAMAP-C committee and also the other ongoing fishery independent sampling initiatives. The group noted that the SEDAR14 DW discussed a recent proposal submitted to the SEAMAP-C committee, the objective which was to evaluate the current reef fish sampling methods and protocols of the SEAMAP-C and to develop pilot studies for enhancing the spatial and temporal coverage of the study. The group noted that the SEMAP-C committee has recently submitted a letter of support regarding that study (SEDAR14 AW RW-49). Research efforts such as these are encouraged.

A research need exists for evaluating impacts from management measures. In particular monitoring of closed areas should be conducted through carefully conducted scientific experiments in such no take areas. Researchers are encouraged to collaborate with fishers in the areas to utilize their knowledge in planning these experiments and to seek funding through such initiatives as NOAA, CRP process.

SEDAR14 AW Table 1. Annual distribution of commercial landings (N=number of sales tickets) of mutton snapper**,** *Lutjanus analis,* in Puerto Rico by major gear category from 1983-2005. 2005 Preliminary data. Data available beginning in 1983.
Table taken from Table 3c. SEDAR14 DW-07. No spatial exclusions performed.

	Gear Category																			
	Cast Net pounds		Dive, Spear, Scuba pounds		Net pounds		Other pounds		Pot pounds		Rod and Reel pounds		Seine pounds		Verticcal Line pounds		All Gears pounds	
cyear	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN	N	RowPc-tN
1983	3	0	84	4	109	6	.	.	1086	56	534	27	108	6	28	1	1952	100
1984	2	0	29	2	92	7	.	.	760	54	395	28	106	8	14	1	1398	100
1985	.	.	42	3	197	15	.	.	606	45	446	33	44	3	19	1	1354	100
1986	4	0	124	10	268	21	.	.	449	35	359	28	61	5	11	1	1276	100
1987	9	1	72	6	186	16	.	.	374	32	402	34	98	8	26	2	1167	100
1988	2	0	118	10	163	14	2	0	333	29	466	40	30	3	41	4	1155	100
1989	6	0	166	12	183	13	2	0	425	30	587	41	42	3	27	2	1438	100
1990	1	0	202	15	145	11	.	.	418	31	535	40	13	1	18	1	1332	100
1991	9	0	233	11	280	13	.	.	641	30	907	42	33	2	36	2	2139	100
1992	1	0	120	8	163	11	.	.	480	32	643	43	50	3	38	3	1495	100
1993	10	1	201	12	152	9	.	.	466	29	732	45	54	3	19	1	1634	100
1994	21	1	130	8	200	12	.	.	502	30	699	42	34	2	66	4	1652	100
1995	32	1	176	6	285	10	.	.	879	30	1379	47	89	3	92	3	2932	100
1996	14	0	235	6	631	17	.	.	1119	30	1438	39	84	2	173	5	3694	100
1997	44	1	251	7	710	18	.	.	1270	33	1366	36	66	2	134	3	3841	100
1998	12	0	310	9	509	14	.	.	1121	31	1453	41	28	1	144	4	3577	100
1999	6	0	301	8	631	16	.	.	1278	32	1567	40	22	1	138	3	3943	100
2000	9	0	327	8	683	17	.	.	1320	32	1609	39	18	0	135	3	4101	100
2001	10	0	343	8	711	17	.	.	1294	30	1739	41	44	1	120	3	4261	100
2002	4	0	397	9	753	17	.	.	1376	31	1757	39	60	1	154	3	4501	100
2003	.	.	386	9	673	15	.	.	1657	37	1516	34	61	1	129	3	4422	100
2004	.	.	689	20	410	12	.	.	1217	35	991	29	40	1	84	2	3431	100
2005	.	.	536	21	234	9	.	.	801	31	906	35	12	0	73	3	2562	100
All	199	0	5472	9	8368	14	4	0	19872	34	22426	38	1197	2	1719	3	59257	100

[1]Prior to 1987 mutton snapper was classified in the Puerto Rico commercial landings as “first class fish” (Matos-Caraballo, 2004).
. = No Reported Sales this cell. N= number observations, RowPctN= percentage of observations within a year.

SEDAR14 AW Table 2. Nominal unadjusted catch per unit of effort (CPUE) for mutton snapper commercial catches in Puerto Rico, 1983-2005, by gear and year for fisher sales where the 'ntrips' variable was coded as ntrips=1 trip. Nominal CPUE calculated as pounds per landed trip. Table reprinted from Table 12a SEDAR14 DW-07. Nominal CPUE is based on excluding trips where 'NTrips variable >1.

	Cast Net		Dive, Spear, Scuba		Net		Pot		Rod and Reel		Seine		Verticcal Line		All Gears	
	cpue		cpue		cpue		cpue		cpue		cpue		cpue		cpue	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean		
1983	*	10	41	26.4	19	14.7	306	13.1	210	15.2	18	11.8	12	9.4	607	14.7
1984	*	60	3	11.7	6	89.7	85	44.8	18	63.3	7	152	*	179	122	57.4
1985	.	.	3	8.3	36	19.1	69	16.6	68	17.7	4	23.3	*	35	182	17.7
1986	*	10	*	7	10	38.7	10	19.2	12	22.1	*	6	.	.	35	24.8
1987	.	.	*	12	*	72	8	11.5	9	13.2	*	30	.	.	20	16.3
1988	*	7.5	97	17.7	135	21.1	237	13.9	366	19.5	28	23.1	36	22.4	903	18.3
1989	4	73	138	23.1	120	15.4	303	18.9	376	21.2	25	30.6	19	21	986	20.4
1990	*	15	147	13.5	78	17	125	17.1	267	15.4	*	85	3	9.7	623	15.7
1991	4	34	149	11.7	156	13.9	215	16.6	399	17.3	3	15.7	26	12.4	952	15.6
1992	*	9	64	16.1	107	13.4	130	12.4	275	19.1	9	29.7	21	17.4	607	16.4
1993	3	11.7	93	12.1	83	10	132	13.7	297	15.2	50	35.5	18	7.1	676	15.1
1994	11	76.6	81	14.3	122	19.6	229	13.4	421	27	26	76.8	23	19.7	913	23.3
1995	26	23.3	109	12.2	163	17.9	488	11.6	798	27.5	59	18.6	39	13.3	1682	20.3
1996	4	18	149	10.1	260	16.9	431	12.1	807	26.2	38	18.7	45	13.1	1734	19.4
1997	26	21.8	171	12.1	281	13.7	323	12	778	29.5	12	30.3	10	23.3	1601	21.2
1998	5	16	130	14.1	160	18	413	12.1	649	23.4	8	39.2	66	6.9	1431	18
1999	*	30	197	12	366	16.7	736	13.6	833	23.7	5	70	61	9.6	2199	17.8
2000	4	9.6	246	16.5	380	18.1	758	15.1	940	18.9	10	28.4	85	12.9	2423	17.2
2001	10	21.6	290	15	488	17.9	781	12.6	1238	22.8	30	73.7	66	9.9	2903	18.7
2002	*	18.6	279	21.2	513	15.2	861	12.5	1202	17.9	52	56	107	9.9	3016	16.6
2003	.	.	385	10.7	661	11.2	1641	11.7	1484	29.2	61	40.3	129	12.6	4361	17.9
2004	.	.	689	8.8	410	12.8	1214	11.4	990	19.3	39	33.1	84	16.5	3426	13.7
2005	.	.	536	9.4	234	10.4	801	11	903	17.7	12	19.3	73	13.1	2559	13.1
All	107	28.7	3999	12.9	4789	15.3	10296	13	13340	22.5	500	38.6	927	13.2	33961	17.5

[1]Prior to 1987 mutton snapper was classified in the Puerto Rico commercial landings as "first class fish" (Matos-Caraballo, 2004).
.- No reported sales this cell. There were 3 positive landings observations from gear=unknown that were excluded.

SEDAR14 AW Table 3. Number of mutton snapper with accepted length measurements from Puerto Rico by gear. Reprinted from SEDAR14 DW Catch Report Table 13.

	dive	gillnet	hook & line	seine	trap	other	total
1983	-	-	1	-	58	-	59
1984	4	-	26	-	216	5	251
1985	1	-	14	-	113	1	129
1986	-	16	16	66	113	8	219
1987	2	1	3	14	33	3	56
1988	3	8	26	24	49	50	160
1989	6	20	22	3	48	63	162
1990	5	105	48	54	43	22	277
1991	5	3	297	5	80	30	420
1992	13	-	203	88	34	55	393
1993	2	8	104	44	14	3	175
1994	1	1	38	38	8	-	86
1995	3	-	84	7	5	-	99
1996	4	-	10	2	6	-	22
1997	-	4	7	-	31	-	42
1998	12	13	106	52	28	2	213
1999	12	130	60	27	68	6	303
2000	11	-	141	73	66	3	294
2001	16	6	43	124	57	3	249
2002	8	-	162	170	100	15	455
2003	-	3	301	214	37	21	576
2004	9	4	138	202	42	1	396
2005	21	4	131	85	20	-	261
2006	9	-	13	196	6	-	224

SEDAR14 AW Table 4. Mutton snapper sampling fractions from Puerto Rico. Reprinted from SEDAR14 DW Catch Report Table 15.

	dive	gillnet	hook & line	seine	trap
1983			0.0%		0.3%
1984	1.7%		0.3%		1.2%
1985	0.5%		0.4%		0.8%
1986		0.2%	0.8%	9.3%	3.6%
1987	0.2%	0.1%	0.2%	0.5%	1.8%
1988	0.3%	0.2%	0.6%	3.4%	1.3%
1989	0.5%	1.1%	0.3%	0.1%	0.3%
1990	0.4%	2.9%	1.0%	7.6%	0.6%
1991	0.4%	0.0%	3.6%	0.2%	0.3%
1992	2.3%		2.5%	4.8%	0.8%
1993	0.3%	0.3%	3.3%	2.4%	0.3%
1994	0.3%	0.0%	0.8%	1.6%	0.1%
1995	0.2%		0.4%	0.2%	0.1%
1996	0.6%		0.1%	0.1%	0.0%
1997		0.0%	0.1%		0.3%
1998	1.4%	0.1%	1.6%	4.2%	0.2%
1999	0.5%	0.5%	0.2%	1.6%	0.3%
2000	0.3%		1.2%	9.8%	0.3%
2001	0.6%	0.0%	0.3%	3.1%	0.5%
2002	0.1%		1.1%	5.8%	0.4%
2003		0.0%	1.0%	5.1%	0.1%
2004	0.3%	0.0%	0.8%	14.6%	0.2%
2005	0.6%	0.0%	1.8%		0.1%
2006					
Range %	0.1 - 2.3	0.0-2.9	0.0-3.6	0.1-9.8	0.0-3.6
Average %	0.59	0.36	0.97	4.13	0.60

SEDAR14 AW Table 5. Number of mutton snapper with accepted length measurements from St. Thomas / St. John by gear. Reprinted from SEDAR14 DW Catch Report Table 16.

	mutton snapper		
	traps	**other**	**total**
1983	-	-	-
1984	38	2	40
1985	87	17	104
1986	13	-	13
1987	7	-	7
1988	-	-	-
1989	-	-	-
1990	-	-	-
1991	6	-	6
1992	2	-	2
1993	4	-	4
1994	4	-	4
1995	-	2	2
1996	-	-	-
1997	-	-	-
1998	-	-	-
1999	-	-	-
2000	-	-	-
2001	-	-	-
2002	13	5	18
2003	3	-	3
2004	2	-	2
2005	39	-	39
2006	22	-	22

SEDAR14 AW Table 6. Number of mutton snapper grouper with accepted length measurements from St. Croix by gear. Reprinted from SEDAR14 DW Catch Report Table 17.

	mutton snapper			
	hook & line	**traps**	**other**	**total**
1983	8	30	53	91
1984	188	20	247	455
1985	63	4	17	84
1986	3	20	2	25
1987	10	25	3	38
1988	88	18	-	106
1989	7	14	-	21
1990	2	5	1	8
1991	9	11	1	21
1992	4	2	-	6
1993	5	2	1	8
1994	1	8	-	9
1995	2	-	1	3
1996	1	-	-	1
1997	-	2	-	2
1998	-	1	-	1
1999	-	10	-	10
2000	-	1	-	1
2001	-	-	-	-
2002	-	6	5	11
2003	1	-	15	16
2004	-	-	1	1
2005	1	14	1	16
2006	-	-	-	-

SEDAR14 AW Table 7. Standardized CPUE indices for the Puerto Rico Mutton Snapper Commercial Line fishery, 1989-2005. Year = Calendar Year, STDCPUE=Index, LCI and UCI are 0.95 Upper and Lower Confidence Intervals. Obcpue=Nominal log(CPUE), obppos=proportion of positives log(CPUE), Cv_i=CV(Index).

YEAR	StdErr	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1989	0.292628	1.714655	0.077873	3968	0.188838	1.773522	0.873755	0.600899	1.270509	1.549624	0.73912
1990	0.377138	1.767548	0.115385	2080	0.215449	1.773522	0.987007	0.644619	1.511256	1.75048	0.76192
1991	0.282804	1.831079	0.106236	3031	0.207242	1.773522	0.769434	0.510567	1.159552	1.364609	0.789305
1992	0.330374	1.553954	0.078642	2238	0.217456	1.773522	0.856639	0.557308	1.316742	1.519269	0.669848
1993	0.220312	1.017553	0.06167	3616	0.205163	1.773522	0.605483	0.403397	0.908805	1.073837	0.438627
1994	0.262045	2.38644	0.075202	4202	0.190618	1.773522	0.775134	0.531231	1.13102	1.374717	1.028699
1995	0.268009	2.468328	0.080045	7146	0.157635	1.773522	0.958651	0.700777	1.311418	1.700189	1.063998
1996	0.255867	2.41838	0.085992	7617	0.154661	1.773522	0.932816	0.685886	1.268645	1.65437	1.042468
1997	0.229098	2.402755	0.079456	7652	0.158894	1.773522	0.812976	0.59282	1.114889	1.44183	1.035732
1998	0.315793	2.59266	0.108292	5282	0.156429	1.773522	1.138282	0.834061	1.553466	2.018768	1.117593
1999	0.382245	3.197473	0.121942	5232	0.150392	1.773522	1.433115	1.062631	1.932769	2.541662	1.378304
2000	0.290912	2.287454	0.113383	7188	0.145433	1.773522	1.127877	0.844502	1.506341	2.000315	0.986031
2001	0.284187	2.791383	0.117675	8379	0.143431	1.773522	1.11718	0.839796	1.486183	1.981343	1.203255
2002	0.2903	2.576073	0.138847	7303	0.139527	1.773522	1.173149	0.888681	1.548677	2.080606	1.110443
2003	0.365874	4.277426	0.141862	8896	0.135173	1.773522	1.526175	1.166072	1.997484	2.706705	1.843829
2004	0.296472	2.343065	0.114152	7490	0.146974	1.773522	1.137381	0.849039	1.523648	2.017171	1.010003
2005	0.21456	1.811411	0.099516	7235	0.156114	1.773522	0.774944	0.568181	1.056949	1.37438	0.780827

SEDAR14 AW Table 8. Standardized CPUE indices for the Puerto Rico Mutton Snapper Commercial Pot fishery, 1990-2005. Year =Calendar Year, STDCPUE=Index, LCI and UCI are 0.95 Upper and Lower Confidence Intervals. Obcpue=Nominal log(CPUE), obppos=proportion of positives log(CPUE), Cv_i=CV(Index)

YEAR	StdErr	obcpue	obppos	nobs	cv_i	MEANINDEX	STDCPUE	LCI	UCI	estcpue	obscpue
1990	0.125186	0.650032	0.038313	3106	0.322323	1.031664	0.376467	0.200748	0.705999	0.388388	0.49338
1991	0.162922	0.964225	0.056442	3508	0.270954	1.031664	0.582835	0.342258	0.992517	0.60129	0.731855
1992	0.202722	0.8682	0.070602	1728	0.290394	1.031664	0.676667	0.383027	1.19542	0.698093	0.658972
1993	0.132162	0.617265	0.044142	2424	0.304648	1.031664	0.420502	0.231741	0.763016	0.433817	0.468509
1994	0.170779	0.788712	0.055948	3539	0.255858	1.031664	0.646989	0.390998	1.070579	0.667475	0.598639
1995	0.135566	0.903051	0.076181	5802	0.23001	1.031664	0.571303	0.362787	0.899666	0.589393	0.685423
1996	0.141726	0.895432	0.072647	5451	0.233232	1.031664	0.58901	0.37172	0.933315	0.60766	0.679641
1997	0.106332	0.660293	0.055086	5319	0.251449	1.031664	0.409898	0.249809	0.672578	0.422877	0.501168
1998	0.161944	0.93067	0.080611	4255	0.234569	1.031664	0.669198	0.421243	1.063106	0.690388	0.706387
1999	0.304025	1.695057	0.124463	5351	0.213734	1.031664	1.378786	0.903481	2.10414	1.422444	1.286563
2000	0.303261	2.208763	0.141431	4907	0.205922	1.031664	1.427498	0.949659	2.14577	1.472699	1.67647
2001	0.235089	1.499756	0.118145	6145	0.198333	1.031664	1.148944	0.775689	1.701806	1.185325	1.138328
2002	0.303509	1.677623	0.134262	6100	0.187594	1.031664	1.568241	1.081128	2.274827	1.617898	1.273331
2003	0.387158	2.619283	0.211946	6931	0.169789	1.031664	2.210244	1.577648	3.096496	2.28023	1.988059
2004	0.351781	2.278151	0.200209	5744	0.187866	1.031664	1.815037	1.250605	2.634213	1.872509	1.729137
2005	0.306549	1.823613	0.162856	4636	0.196993	1.031664	1.508381	1.021013	2.228389	1.556143	1.384138

SEDAR14 AW Table 9. Fit Diagnostics from the mean length mortality based estimator model evaluations to the Puerto Rico trap fishery length data.

Mean Lengths computed by:	Weighted (n) Likelihood	Estimated First Mortality Rate (Z_{ONE})	Estimated Second Mortality Rate (Z_{TWO})	Estimated Year of Change
Year	**No**	**0.458**	**0.832**	**1992.42**
Year	**Yes**	**0.478**	**0.647**	**1991.80**
Month	**No**	**0.435**	**0.801**	**1987.81**
Month	**Yes**	**0.478**	**0.645**	**1992.24**
Interview Day	**No**	**0.391**	**0.810**	**1988.36**
Interview Day	**Yes**	**0.478**	**0.645**	**1992.23**

SEDAR14 AW Table 10. Shows estimates of total mutton snapper abundance (number of individuals) by life stage for three US Caribbean Islands. Reprinted from SEDAR14 AW02 Table 4 and added column identifying #individuals observed in survey.

Size of study Island area (ha)	% of study area sampled	# of surveys	# mutton observed	Life stage	Estimated abundance	Range of estimate
Puerto Rico 157,285	< 0.1	1013	3	Juvenile	18,865	4,979 -32,750
			0	Adult	-	---
			3	**Total**	**18,865**	**4,979 -32,750**
St. Croix 32,014	0.1	1275	49	Juvenile	78,592	30,860 -126,325
			13	Adult	28,085	10,618 -10,618
			49	**Total**	**106,678**	**41,478 -136,943**
St. John 4,684	0.2	845	18	Juvenile	8,896	2,146 -15,645
			20	Adult	7,447	1,553 -13,340
			38	**Total**	**16,342**	**3,698 -28,986**

Table 11. Current Management Criteria. Values in Table 2 are for Snapper Unit 3 (Mutton Snapper, Indicator Species)

Criteria	Current		Proposed	
	Definition	Value	Definition	Value
MSST	MSST = B_{MSY}(1-c); where c = the natural mortality rate (M) or 0.50, whichever is smaller.	1,682,000 lbs Bcurr/MSST=1.43 Bcurr/Bmsy=1.00	MSST = B_{MSY}(1-c); where c = the natural mortality rate (M) or 0.50, whichever is smaller.	UNK (SEDAR 14)
MFMT	Specify an MSY control rule to define ABC = F_{MSY}. When the data needed to determine F_{MSY} are not available, use natural mortality (M) as a proxy for F_{MSY}.	F_{MSY} = 0.30 Fcurr/Fmsy=1.00	Specify an MSY control rule to define ABC = F_{MSY}. When the data needed to determine F_{MSY} are not available, use natural mortality (M) as a proxy for F_{MSY}.	UNK (SEDAR 14)
MSY	Yield at F_{MSY}. In the absence of MSY estimates, the proxy for MSY will be derived from recent average catch (C), as: MSY = C / [(F_{CURR}/F_{MSY}) x (B_{CURR}/B_{MSY})].	542,000 pounds	Yield at F_{MSY}. In the absence of MSY estimates, the proxy for MSY will be derived from recent average catch (C), as: MSY = C / [(F_{CURR}/F_{MSY}) x (B_{CURR}/B_{MSY})].	UNK (SEDAR 14)
F_{MSY}	M	0.30	F_{MSY}	UNK (SEDAR 14)
OY	Yield at $F_{OY.}$ F_{OY} = 0.75F_{MSY}.	508,000 pounds	Yield at $F_{OY.}$ F_{OY} = 0.75F_{MSY}.	UNK (SEDAR 14)
F_{OY}	F_{OY} = 0.75F_{MSY}.	0.225	F_{OY} = 0.75F_{MSY}.	UNK (SEDAR 14)
M	n/a	0.30	SEDAR 14	UNK (SEDAR 14)
Probability value for evaluating status		(Not Specified)		(Not Specified)

SEDAR14 AW Table 12. SEDAR14 Assessment Workshop: Data and Analytical Status overview. PR=Puerto Rico, STT= St. Thomas, STX=St. Croix. Conch=Conch (Stromgbias gigas*)* YFG=Yellwowfin Grouper (*Mycterperca venenosa*), MTS=Mutton Snapper (*Lutjanus analis*).

	MTS		
Attribute	PR	STT	STX
Commercial Landings	Fair, 1983+ adj. conc improving	No Species information	No Species information
Commercial Lengths	Fair, some gears, 1983+, improving. Need to increase sampling fraction, need to insure representative sampling	very un- comnon 200 fish sampled in 20 years , Need to increase sampling fraction, need to insure representative sampling	fair 1983-1988, then none; Need to increase sampling fraction, need to insure representative sampling
Commercial Discard	No info	No info	No Info
Recreational Landings	MRFSS 2000-05 numbers, weight smples poor	No info	no Info
Recreational Landings	CHK	No Info	no Info
Recreational Discards	CHK	No Info	no Info
AGE Observations	None	None	None
Independent Indices	Possibility NOS Habitat CMP lowN	NOS Habitat	NOS habitat
Dependent Indices	Com CPUE 1989+	No Info	No Info
Life History	No ages here maybe other areas		
Stock ID	UNK	UNK	UNK
To DO, AW	relative efforts		
Analytical Options	Length , Prod models-short time series, recreational yield not known		
Comments			
Recommendations			
Future Discussions:	Com vs. recreational catch compare CPUE reflect abundance? YPR using other area growth model, backcast recreational-but would introduce additional uncertainty to do prod mod?		

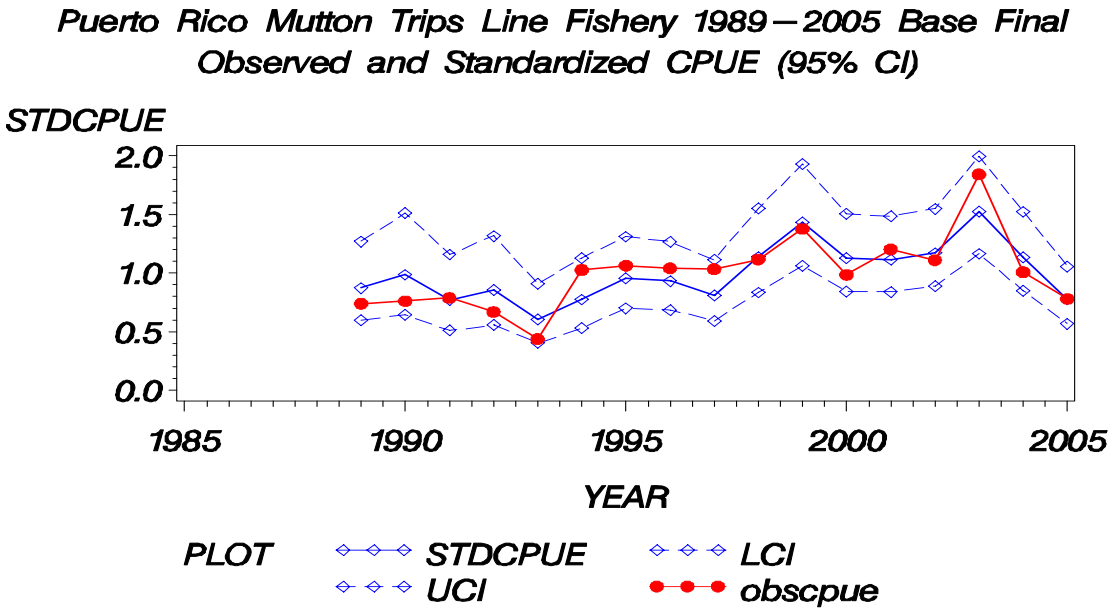


Figure 1. Standardized mutton snapper CPUE, 95% confidence interval and, nominal CPUE of mutton snapper from the Puerto Rico line fishery, 1989-2005. CPUE is measured in Lbs per trip

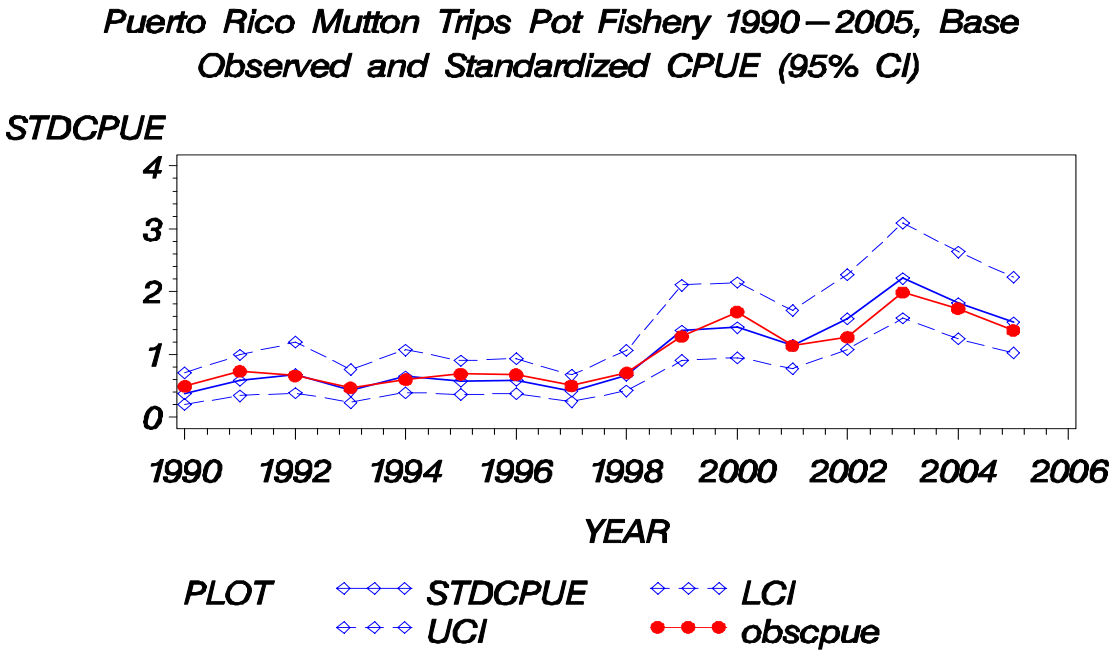


Figure 2. Standardized mutton snapper CPUE, 95% confidence interval, and nominal CPUE from the Puerto Rico commercial pot fishery, 1990-2005. CPUE is measured in Lbs per Trip.

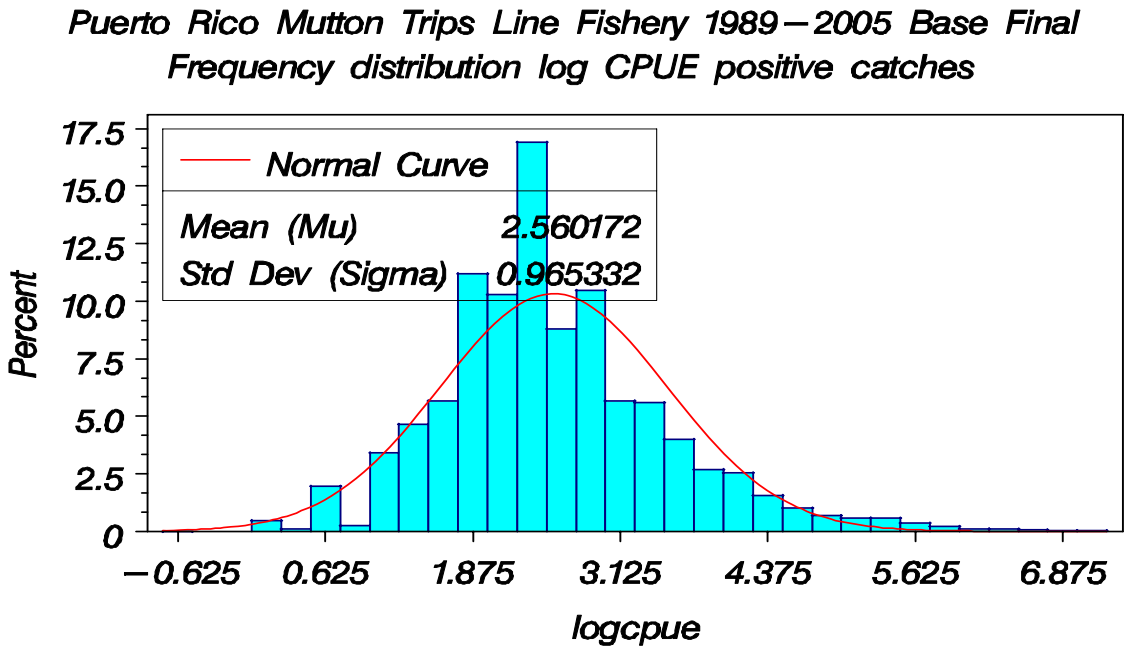


Figure 3. Frequency distribution of log(CPUE) of mutton snapper successful trips from the Puerto Rico commercial line fishery, 1989-2005. CPUE is measured in Lbs per Trip.

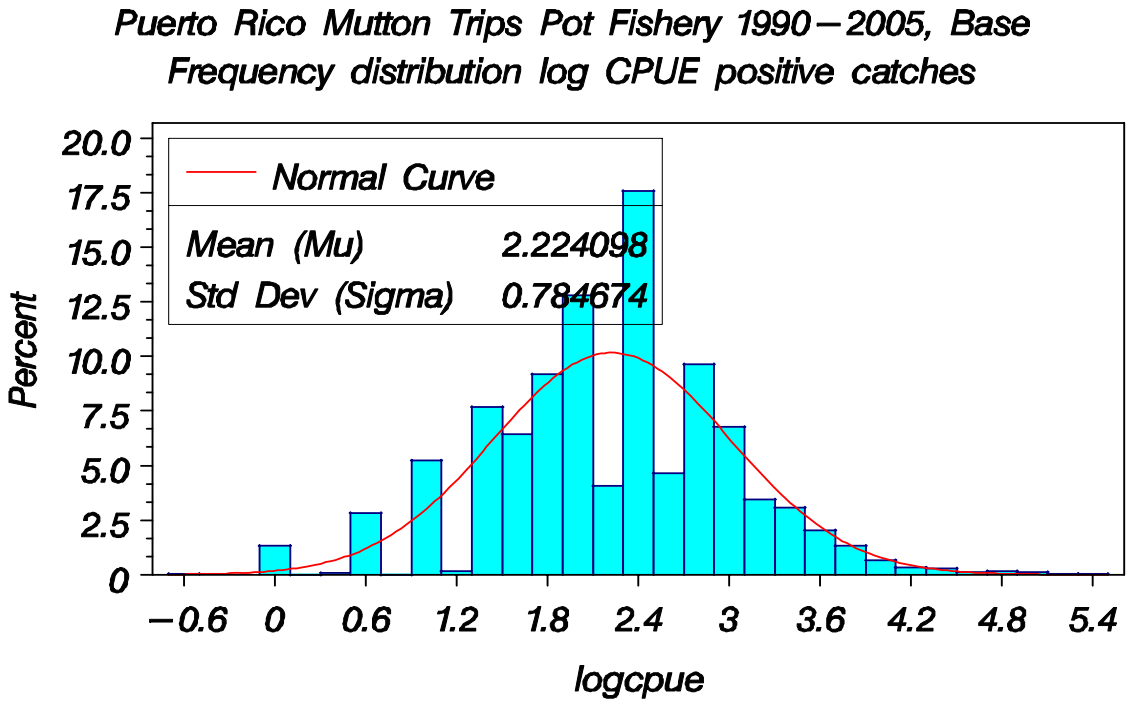


Figure 4. Frequency distribution of log(CPUE) of mutton snapper positive (successful) trips from the Puerto Rico commercial pot fishery, 1990-2005.

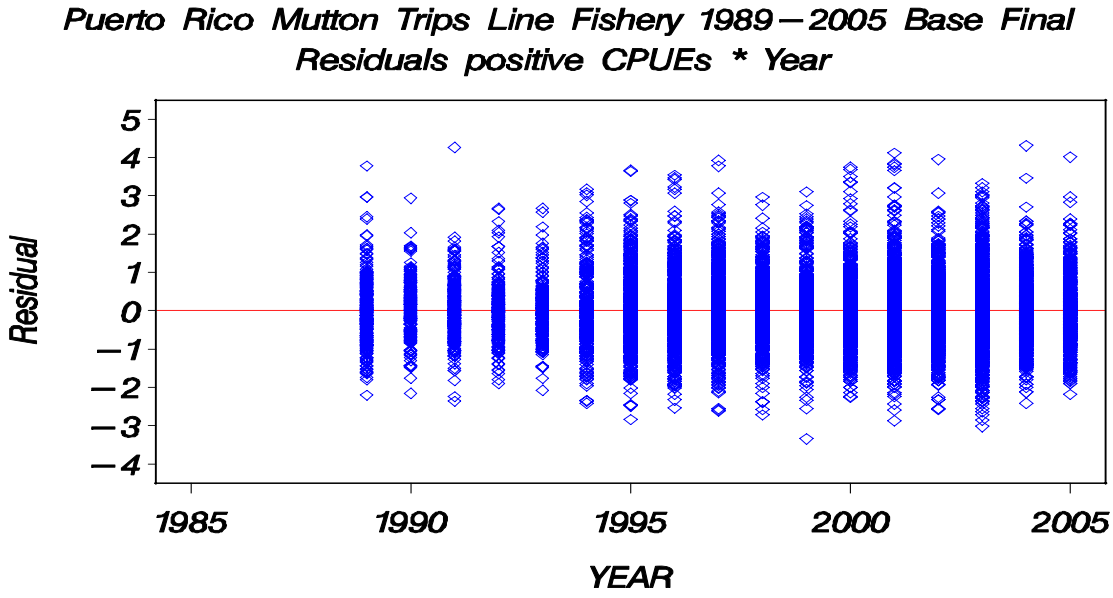


Figure 5. Residual distribution of the final delta lognormal model for the positive (successful) observations for mutton snapper from the Puerto Rico commercial line fishery, 1989-2005..

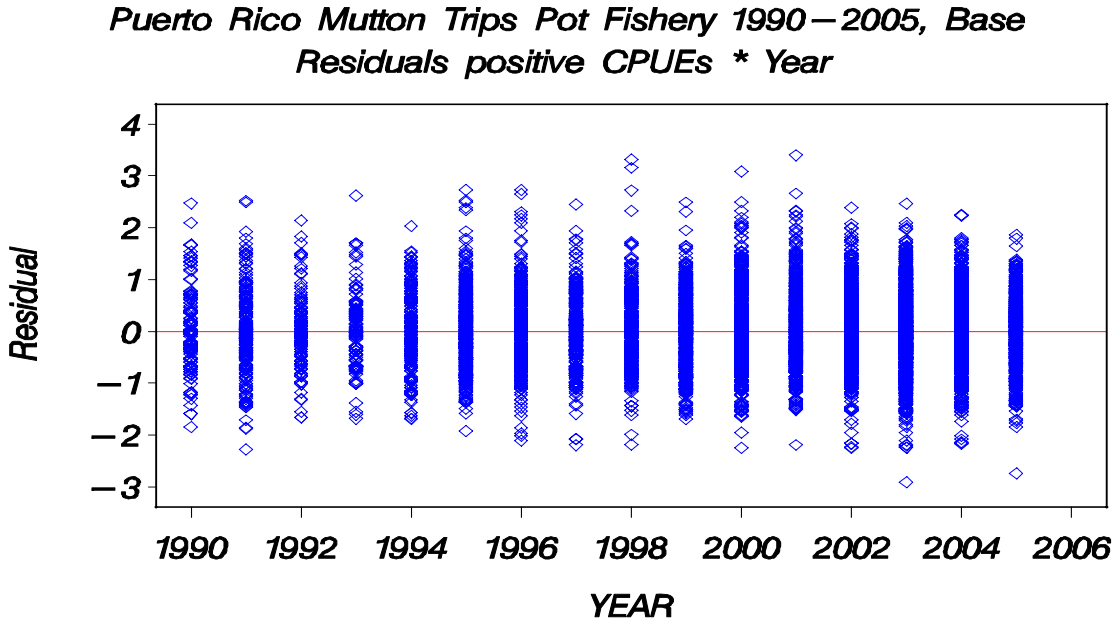


Figure 6. Residual distribution of the final delta lognormal model for the positive (successful) observations for mutton snapper from the Puerto Rico commercial line fishery, 1989-2005

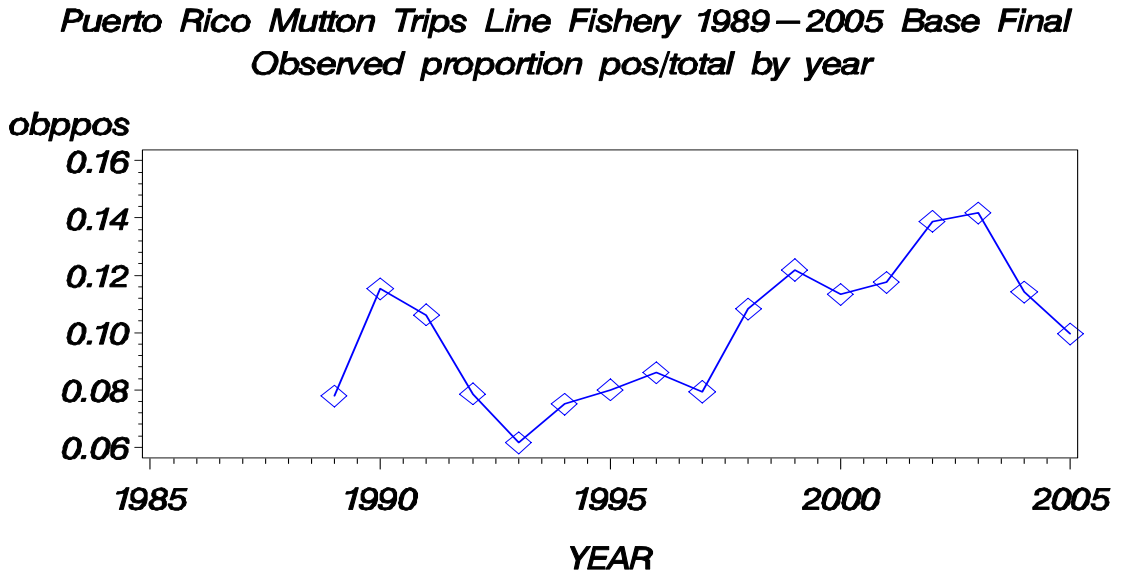


Figure 7. Observed average annual proportion of positive (successful) trips for mutton snapper from the commercial line fishery in Puerto Rico, 1989-2005

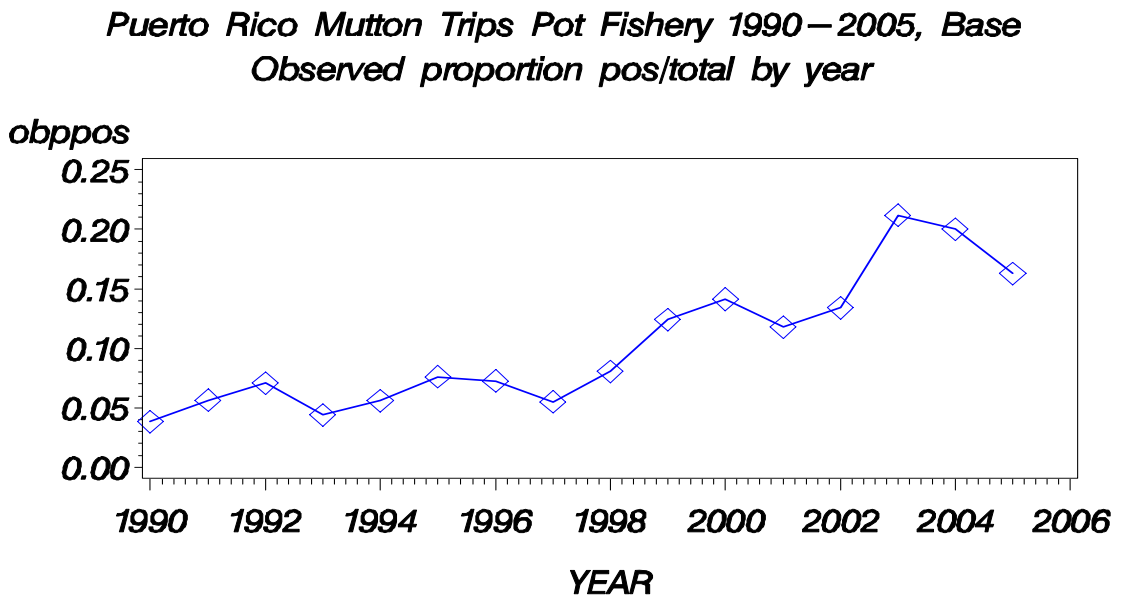


Figure 8. Observed average proportion of positive (successful) trips for mutton snapper from the Puerto Rico commercial pot fishery, 1990-2005.

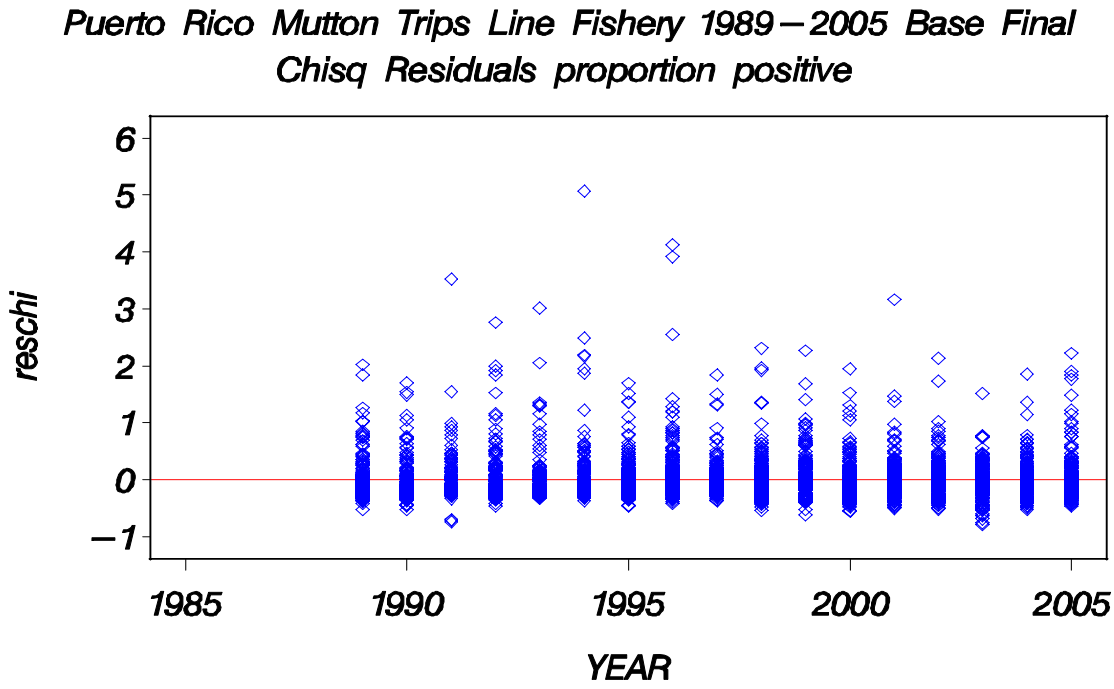


Figure 9. Residual distribution of proportion positives from the final delta lognormal model by year, for mutton snapper from the Puerto Rico line fishery, 1989-2005

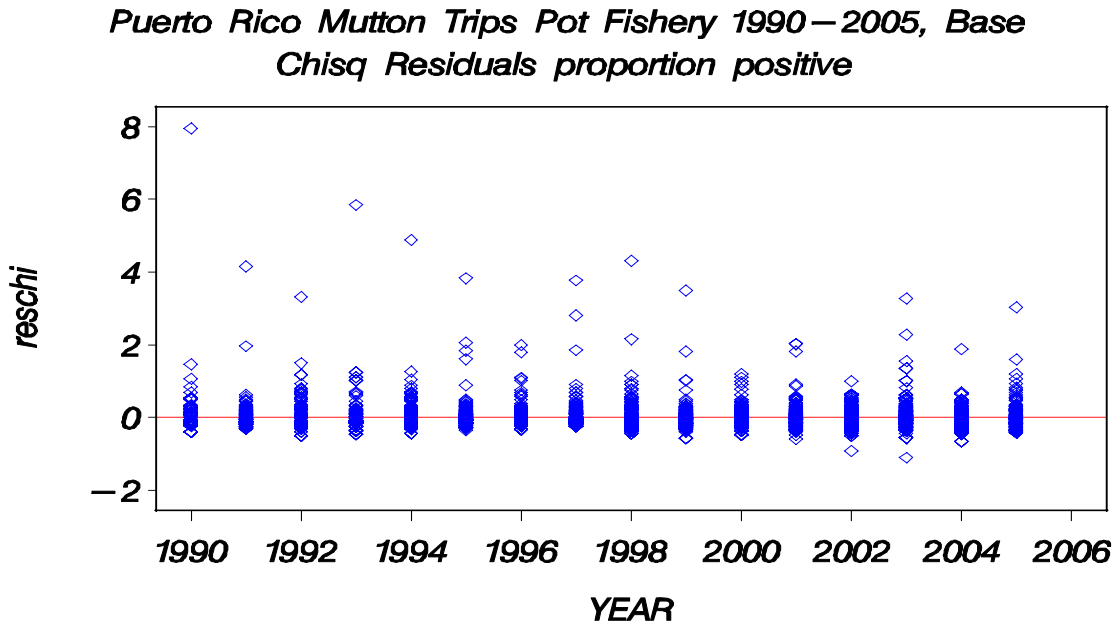


Figure 10. Residual distribution from the final delta lognormal model by year, of the proportion positives (successful) for mutton snapper from the Puerto Rico pot fishery, 1990-2005.

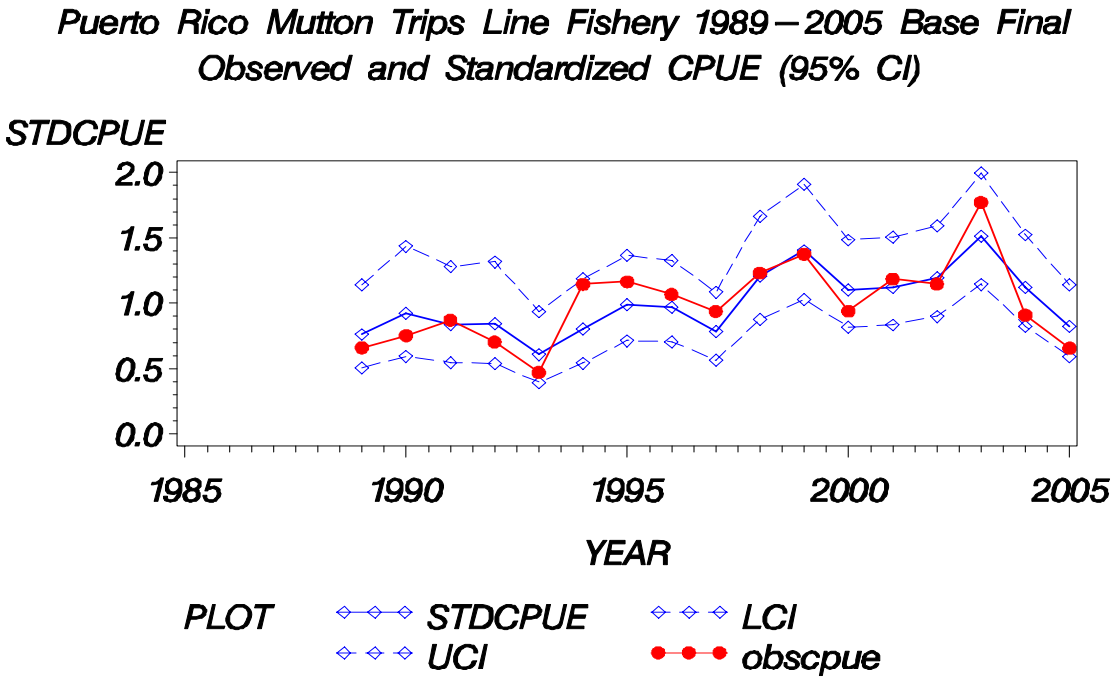
Figure 11. SEDAR14 AW sensitivity trial for hook and line fishery standardized CPUE of mutton snapper in Puerto Rico. Sensitivity trial data set excluded observations from the months of April and May 2004-2005 from the analysis.

Model Input: Same as Best Model from Line Fishery Base:

Positive log (CPUE)=Year + Municipality + Month + Year * Municipality

Proportion Positives = Year + Municipality + Month + Year*Municipality.

Deviance: 6456.3 AICC 23,280.3, Year term p=.0455, Month and Area effects p<0.0001
Over Dispersin =1.7 for binomial model and 0.72 for lognormal



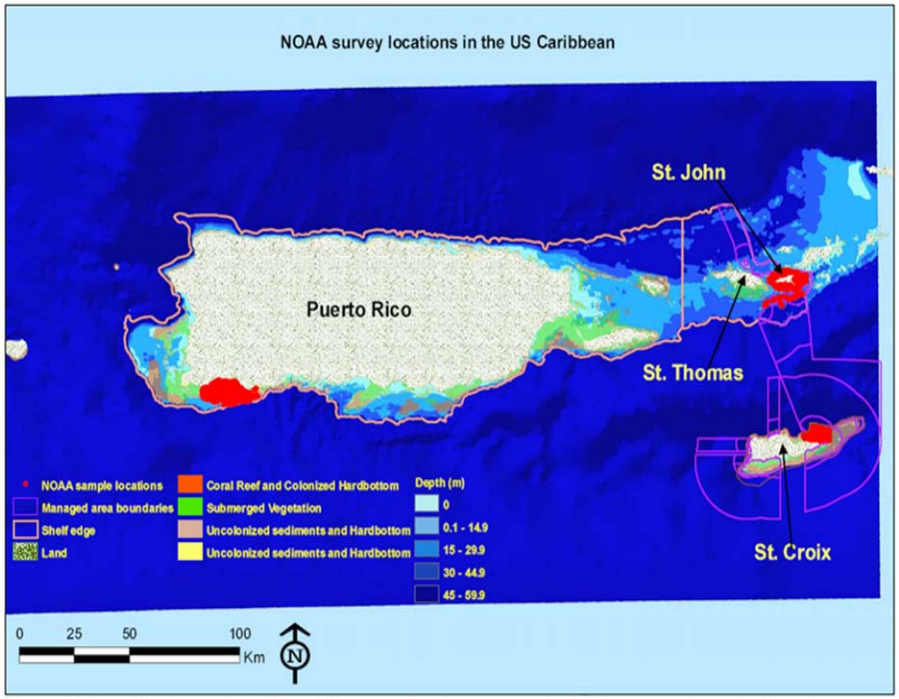


Figure 1. Map of locations where NOAA Biogeography Team conducted visual censuses for conch (*Strombus gigas*) and mutton snapper (*Lutjanus analis*) between 2001 and 2006.

Figure 12. Mutton snapper habitat model study area. Reprinted from SEDAR14 AW02, Figure 1.

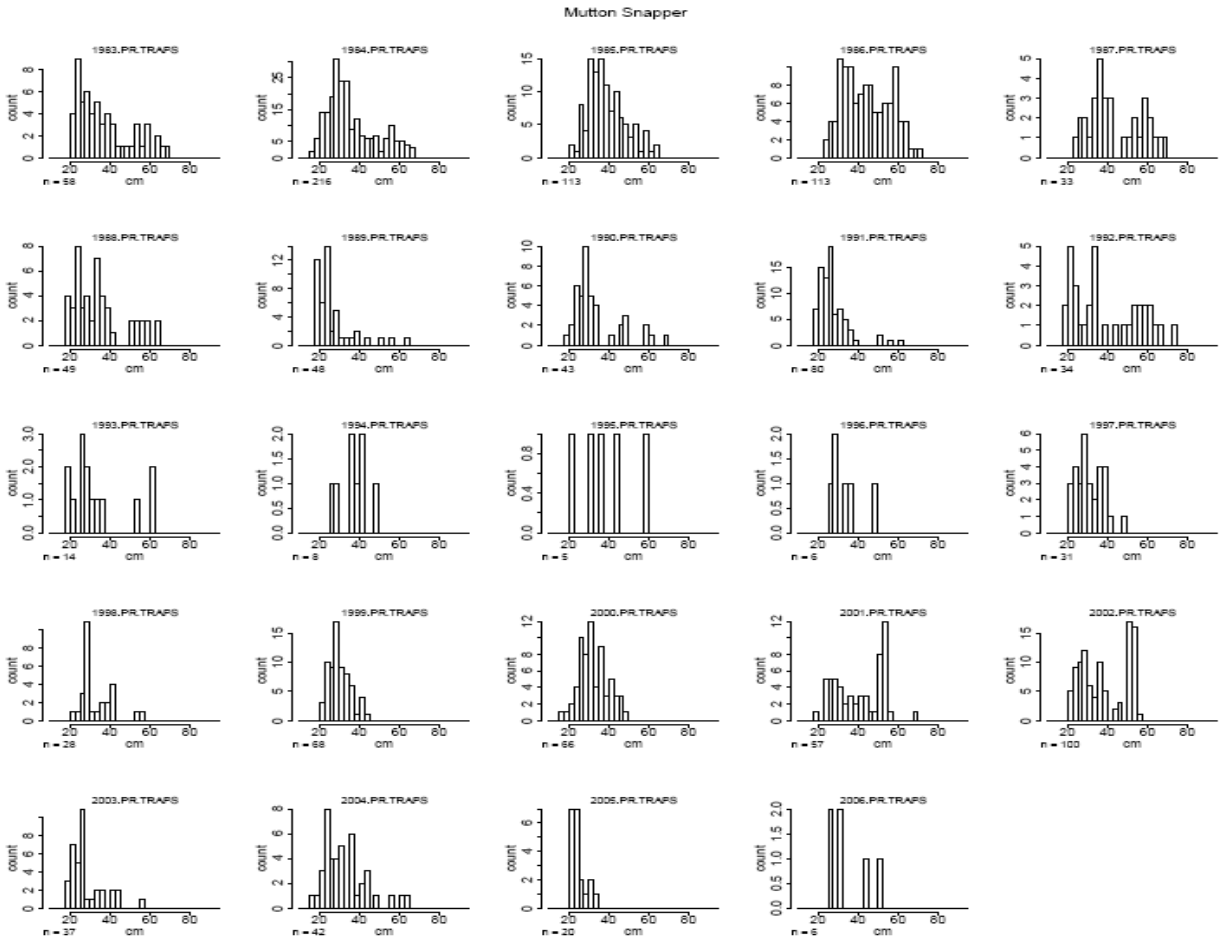


Figure 13. Number of mutton snapper at length (cm) from Puerto Rican landings by trap fisheries from 1983 through 2006. Note that the vertical axes vary in scale.

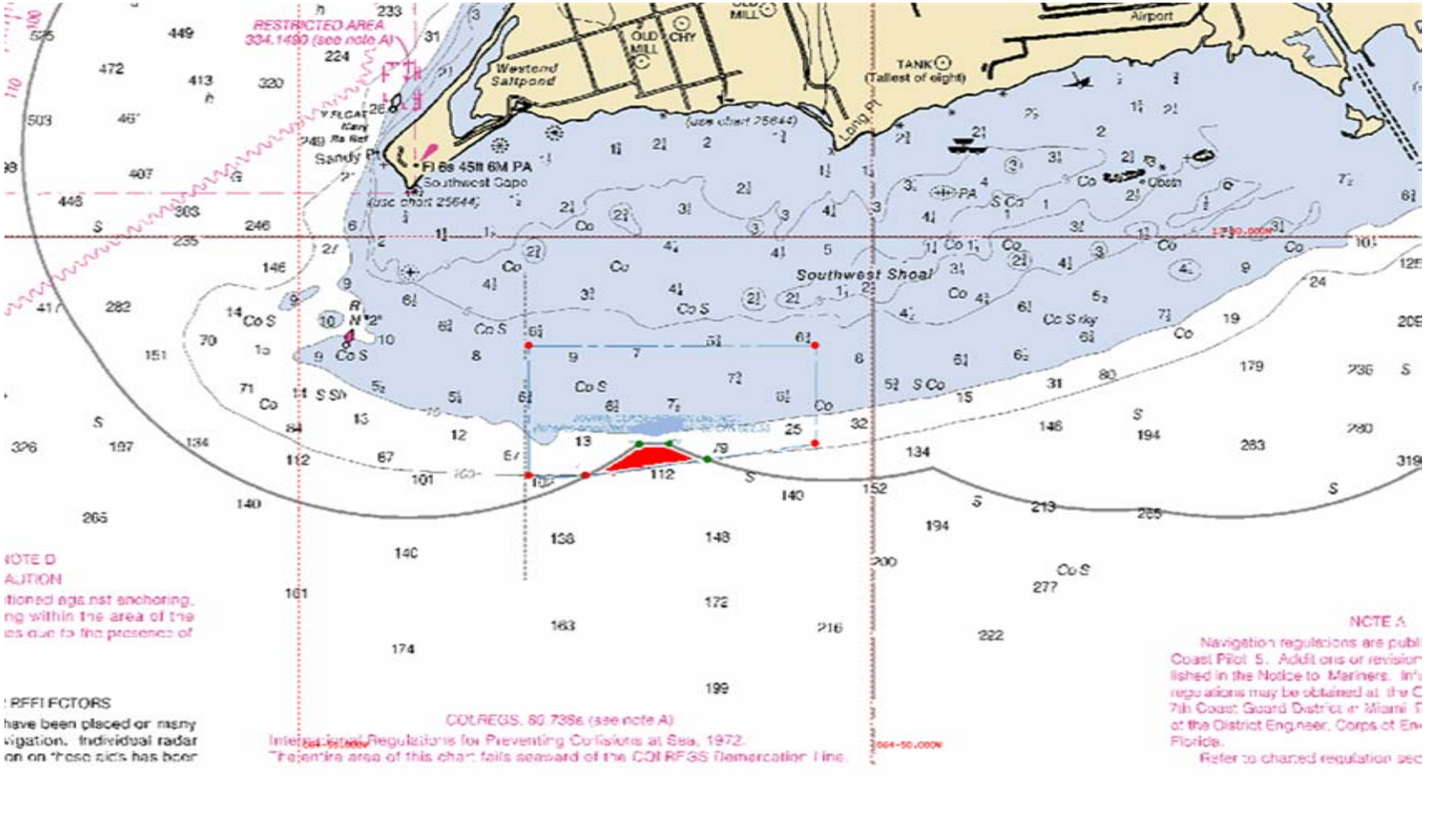


Figure 14. Mutton snapper seasonal closure location off St. Croix. Figure provided by Graciela Garcia-Moliner CFMC.